CLAIMS

What is claimed is:

1. A metrology device that detects the polarization state of a pulsed electromagnetic beam that is incident on a sample, said device comprising:

a polarization state generator, including an electromagnetic source that turns on and off to produce a pulsed electromagnetic beam, wherein the polarization state generator produces a pulsed electromagnetic beam of known polarization state that is incident on the sample;

a spatially dependent polarizing element in the path of the pulsed electromagnetic beam; and

a multi-element detector within the path of the pulsed electromagnetic beam after the spatially dependent polarizing element, wherein the multi-element detector detects the intensity of the pulsed electromagnetic beam as a function of position.

2. The metrology device of Claim 1, wherein the electromagnetic source is selected from the group consisting of a flash bulb and a pulsed laser.

3. The metrology device of Claim 1, wherein the spatially dependent polarizing element comprises:

a spatial variable phase retarder; and

a polarizer after the spatial variable phase retarder.

4. The metrology device of Claim 1, further comprising a beam expander within the path of the pulsed electromagnetic beam before the spatially dependent polarizing element.

5. The metrology device of Claim 4, wherein the beam expander and the spatially dependent polarizing element are located in the pulsed electromagnetic beam path after interaction with the sample.

6. The metrology device of Claim 1, further comprising a wavelength-dispersing component within the path of the pulsed electromagnetic beam, the wavelength-dispersing component separates the component wavelengths of the pulsed electromagnetic beam.

7. The metrology device of Claim 1, further comprising a synchronizer coupled to the electromagnetic source and the multi-element detector, wherein the synchronizer causes the multi-element detector to read out the intensity of the pulsed electromagnetic beam as a function of position when the electromagnetic source is turned off.

8. The metrology device of Claim 7, wherein the electromagnetic source produces a plurality of pulsed electromagnetic beams after the synchronizer causes the multi-element detector to detect the intensity of the plurality of pulsed electromagnetic beams as a function of position.

9. A method of ellipsometrically measuring a sample, the method comprising:

turning on and off an electromagnetic beam to produce a pulsed electromagnetic beam to be incident on a sample;

polarizing the pulsed electromagnetic beam prior to being incident on the sample;

producing a spatially dependent relative phase difference between the electric field components of the pulsed electromagnetic beam;

polarizing the pulsed electromagnetic beam after a spatially dependent relative phase difference is produced; and

detecting the intensity of the polarized pulsed electromagnetic beam at a plurality of positions.

10. The method of Claim 9, wherein the spatially dependent relative phase difference is in a first direction, the method further comprising:

filtering the wavelengths of the pulsed electromagnetic beam spatially in a second direction that is perpendicular to the first direction;

wherein detecting the intensity of the polarized pulsed electromagnetic beam detects the intensity as a function of the spatially dependent relative phase shift in the first direction and the wavelengths in the second direction.

11. The method of Claim 9, further comprising turning on and off the electromagnetic beam to produce a plurality of pulsed electromagnetic.

12. The method of Claim 9, further comprising expanding the pulsed electromagnetic beam prior to producing a spatially dependent relative phase difference.

13. The method of Claim 9, further comprising:

reading out the detected intensity of the polarized pulsed electromagnetic beam at a plurality of positions; and

synchronizing the reading out the detected intensity of the polarized pulsed electromagnetic beam with the turning off of the electromagnetic beam.

14. An apparatus for measuring a characteristic of a sample, the apparatus comprising:

a light source that can be turned on and off to produce a pulsed electromagnetic beam;

a polarizer in the path of the pulsed electromagnetic beam, wherein the polarized pulsed electromagnetic beam is incident on the sample;

means for producing a spatially dependent phase shift in the pulsed electromagnetic beam, the means for producing a spatially dependent phase shift producing a phase shifted beam wherein the phase shift is spatially dependent;

means for polarizing within the path of the phase shifted beam, the means for polarizing producing a polarized phase shifted beam; and

means for measuring the intensity of the polarized phase shifted beam as a function of position, the means for measuring being in the path of the polarized phase shifted beam.

15. The apparatus of Claim 14, wherein the light source is selected from the group consisting of a flash bulb and a pulsed laser.

16. The apparatus of Claim 14, the apparatus further comprising a means for dispersing the wavelengths of the expanded pulsed electromagnetic beam, the means for dispersing the wavelengths being in the path of the expanded pulsed electromagnetic beam.

17. The apparatus of Claim 14, further comprising a means for expanding the pulsed electromagnetic beam, the means for expanding being in the path of the pulsed electromagnetic beam.

18. The apparatus of Claim 14, wherein the means for producing a spatially dependent phase shift in the pulsed electromagnetic beam comprises a spatial variable phase retarder.

19. The apparatus of Claim 14, further comprising a means for synchronizing the means for measuring the intensity of the polarized phase shifted beam as a function of position with the turning on and off of the light source.

20. The apparatus of Claim 14, wherein the means for synchronizing comprises a synchronizer coupled to the light source and to the means for measuring the intensity of the polarized phase shifted beam, wherein the synchronizer causes the means for measuring the intensity of the polarized phase shifted beam to read out data when the light source is turned off.

21. The apparatus of Claim 20, wherein the light source produces a plurality of pulsed electromagnetic beams after the synchronizer causes the means for measuring the intensity of the polarized phase shifted beam to read out data.

22. An interferometer for optically measuring a characteristic of a sample, said interferometer comprising:

an electromagnetic source that turns on and off to produce a pulsed electromagnetic beam to be incident on and interact with a sample;

means for splitting said pulsed electromagnetic beam into two beams prior to being incident on said sample and for combining said two beams into a single superimposed electromagentic beam after interacting with said sample;

a spatially dependent polarizing element in the path of said single superimposed electromagentic beam;

a shaping means for shaping said single superimposed electromagnetic beam; and

a multi-element detector within the path of said single superimposed electromagnetic beam after said polarizer, said multi-element detector receives said single superimposed electromagnetic beam, wherein said multi-element detector measures the intensity of said single electromagnetic beam as a function of position;

wherein said shaping means shapes said single superimposed electromagnetic beam to continuously cover said multi-element detector.

23. The metrology device of Claim 22, wherein the electromagnetic source is selected from the group consisting of a flash bulb and a pulsed laser.

24. The metrology device of Claim 22, further comprising a synchronizer coupled to the electromagnetic source and the multi-element detector, wherein the synchronizer causes the multi-element detector to read out the intensity of the pulsed electromagnetic beam as a function of position when the electromagnetic source is turned off.

25. The metrology device of Claim 24, wherein the electromagnetic source produces a plurality of pulsed electromagnetic beams after the synchronizer causes the multi-element detector to read out the intensity of the pulsed electromagnetic beam as a function of position.

26. The metrology device of Claim 22, further comprising a wavelength-dispersing component within the path of said single superimposed electromagnetic beam, said

wavelength-dispersing component separates the component wavelengths of said single superimposed electromagnetic beam.

27. The metrology device of Claim 21, wherein the spatially dependent polarizing state element comprises:

a spatial variable phase retarder; and

a polarizer.